

WHAT IS CLAIMED IS:

- 1 1. A mechanical pump for use in a medical device comprising:
2 an elongate hollow, flexible inner tube having a proximal end, a distal end,
3 and a central lumen; and
4 a first coiled rotor element having a distal end and a proximal end disposed
5 over an outer surface of the inner tube; and
6 a jacket securing the coiled rotor element to the outer surface of the inner
7 tube.
- 1 2. A mechanical pump as in claim 1, wherein the inner tube has an
2 outer diameter in the range from 0.5 mm to 5 mm, and the coiled rotor has a pitch in the
3 range from 1 to 50 turns/cm.
- 1 3. A mechanical pump as in claim 1, further comprising a second
2 coiled rotor element disposed over an inner surface of the central lumen of the inner tube.
- 1 4. A mechanical pump as in claim 3, wherein the first and second
2 coiled rotors are counterwound.
- 1 5. A mechanical pump as in claim 3, wherein the first and second
2 coiled rotors are co-wound.
- 1 6. A mechanical pump as in claim 5, wherein a distal portion of the
2 coiled rotor is unattached to the inner tube to provide a whip element as the pump is
3 rotated.
- 1 7. A mechanical pump as in claim 1, wherein the inner tube
2 comprises a braided tube, a mesh tube, a coil, a stacked coil, or a coil-reinforced polymer
3 tube.
- 1 8. A mechanical pump as in claim 7, wherein the coiled rotor element
2 comprises a single filament, a multi-filar, stacked filaments, or multiple filament cable.
- 1 9. A mechanical pump as in claim 8, wherein the filaments comprise
2 a round wire, a ribbon wire, or a wire having an irregular cross-section.

1 10. A method of making a mechanical pump for use in a medical
2 device said method comprising:
3 providing a hollow flexible tube;
4 placing a resilient coiled rotor over an outer surface of said tube; and
5 forming a jacket over at least a portion of the outer surface of said tube and
6 said coiled rotor, whereby the coiled rotor is secured to the outer surface of the flexible
7 tube.

1 11. A method as in claim 10, wherein placing the coil comprises
2 winding said coil over the surface.

1 12. A method as in claim 10, wherein placing the coil comprises
2 unwinding the coil to increase its diameter and allowing the coil to rewind over the
3 surface to provide an interference fit.

1 13. A method as in claim 10, wherein the jacket comprises a heat
2 shrinkable polymer, wherein forming the jacket comprises heat shrinking the jacket over
3 the inner tube and the coiled rotor.

1 14. A method as in claim 10, wherein forming the jacket comprises
2 dipping the inner tube and rotor into a resin coating and curing the resin to form the
3 jacket.

1 15. A method as in claim 10, wherein forming the jacket comprises
2 bonding the coiled rotor to the inner tube.

1 16. A method as in claim 10, wherein forming the jacket comprises
2 heating the coiled rotor and embedding it into the inner tube.

1 17. A method as in claim 10, wherein the inner tube comprises a
2 braided tube, a mesh tube, a coil, a stacked coil, or a coil-reinforced polymer tube.

1 18. A method as in claim 17, wherein the coiled rotor element
2 comprises a single filament, a multi-filar, a stacked coil, or a multiple filament cable.

1 19. A method as in claim 17, wherein said filaments comprise a round
2 wire, a ribbon wire, or a wire having an irregular cross-section.

1 20. A method as in claim 17, wherein the flexible tube and the jacket
2 both comprise polymers and wherein the method comprises bonding the tube to the
3 jacket.

1 21. A method as in claim 17, wherein forming the jacket comprises
2 spraying a polymer over the inner tube and coiled rotor.

1 22. A method of making a mechanical pump for use in a medical
2 device, said method comprising:
3 providing a hollow flexible tube; and
4 forming a helical channel in an outer surface of the tube.

1 23. A circulation catheter comprising:
2 a catheter body having a proximal end, a distal end, and a lumen
3 therebetween, the lumen forming a distal opening at the distal end of the catheter body;
4 an impeller rotatably disposed in the lumen of the catheter body to aspirate
5 materials from the distal end to the proximal end of the catheter body; and
6 a clearing element disposed at the distal opening of the catheter body to
7 prevent the materials from accumulating at the distal opening.

1 24 . A circulation catheter as in claim 23, further comprising a material
2 capture device disposed at the distal end of the catheter body.

1 25. A circulation catheter as in claim 24, wherein the material capture
2 device comprises a macerator.

1 26. A circulation catheter as in claim 25, further comprising an
2 expansible cage surrounding the macerator.

1 27. A circulation catheter as in claim 26, wherein the macerator is
2 configured to engage at least a portion of the expansible cage.

1 28. A circulation catheter as in claim 25, the impeller comprising a
2 helical rotor having a distal end and a proximal end extending at least partially over an
3 outer surface of a shaft, wherein a distal portion of the shaft extends beyond the distal
4 opening of the catheter body.

1 29. A circulation catheter as in claim 28, wherein the macerator
2 comprises a distal end and a proximal end, and wherein the distal end of the macerator is
3 fixed to the distal end of the shaft, and wherein the proximal end of the macerator extends
4 into the distal opening of the catheter body to form the clearing element.

1 30. A circulation catheter as in claim 28, wherein the rotor comprises a
2 helical coil, and wherein the distal end of the helical coil is unattached to the shaft to form
3 the clearing element.

1 31. A circulation catheter as in claim 28, wherein the clearing element
2 comprises a cutting member coupled to the impeller at or near the distal opening.

1 32. A circulation catheter as in claim 31, wherein the cutting member
2 is attached to the macerator.

1 33. A circulation catheter as in claim 31, wherein the cutting member
2 is attached to the shaft.

1 34. A circulation catheter as in claim 31, wherein the cutting member
2 is attached to the helical rotor.

1 35. A circulation catheter as in any of claims 29-31, wherein the shaft
2 is rotated to induce aspiration through the catheter body lumen, and wherein the clearing
3 element spins relative to the catheter body to clear the distal opening of the catheter body
4 as the shaft is rotated.

1 36. A method for transporting materials between a target site in a body
2 lumen, and a location external to the patient, said method comprising:
3 introducing a distal end of a catheter to the target site;
4 rotating an impeller within a lumen of the catheter to aspirate material
5 from the target site; and
6 clearing an opening of the lumen at the distal end of the catheter body to
7 prevent the material from accumulating at the opening.

1 37. A method as in claim 36, wherein clearing the opening comprises
2 rotating a clearing element inside the distal opening of the catheter body.

1 38. A method as in claim 37, the impeller further comprising a shaft
2 and a helical rotor, wherein rotating the impeller further comprises rotating a macerator
3 attached at a distal end of the impeller shaft.

1 39. A method as in claim 38, wherein clearing the opening of the
2 lumen comprises spinning a proximal end of the macerator inside the distal opening of the
3 catheter body.

1 40. A method as in claim 38, wherein the clearing element is coupled
2 to the impeller, and wherein clearing the opening of the lumen comprises spinning the
3 clearing element inside the distal opening of catheter body as the impeller is rotated.

1 41. A method as in claim 40, wherein the clearing element comprises a
2 cutting disk attached to the shaft of the impeller.

1 42. A method as in claim 40, wherein the clearing element comprises a
2 cutting disk attached to the rotor of the impeller.

1 43. A method as in claim 40, wherein the clearing element comprises a
2 cutting disk attached to the proximal end of the macerator.